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**Battling Stains with Bleach: An Oxidizing Experiment**

*Now you see it—now you don’t! Make color disappear with chemistry!*

**Introduction**

Have you ever wondered why your dirty clothes come out of the washing machine white and clean? What makes all the stains disappear? The answer to that question is bleach—an ingredient that is present in most laundry detergents. Bleach is responsible for the whitening effect that occurs during washing and removes most of the stains. But how does it work? In this lab, you will find out by making food coloring disappear with the power of bleach.

**Background**

The first question to ask is, what makes the stains? Of course, there are many answers to that, which include ketchup, syrup or grass—but what makes the ketchup stain red, the syrup stain brown and the grass stain green? The simple answer is that the color comes from what ketchup, syrup, or grass is made of: their molecules. Some molecules can function as dyes, which have the ability to absorb light in the visible wavelength range (400-700 nanometers). When light interacts with such a molecule, part of the light spectrum is absorbed by its chemical structure. The wavelengths that are not absorbed are reflected instead, which results in us seeing those specific wavelengths (if they fall in the visible spectrum). Grass, for example, appears green to us because its molecules absorb all wavelengths except in the green color range.

Chemical molecules that appear a certain color usually contain **chromophores** in their chemical structure, which can absorb light in the visible wavelength range (instead of the invisible light spectrum). Often, chromophores are aromatic compounds or molecules containing a series of alternating single and double bonds. Food dyes such as Blue 1 (Brilliant Blue), Red 3 (Erythrosine) or Yellow 5 (Tartrazine) are good examples of such compounds. However, the question remains: How can bleach get rid of these color-giving chromophores in the stains?

Most household bleaches are based on chlorine and contain **sodium hypochlorite (NaClO)**. This is an **oxidizing agent**, which causes a reaction to form another chemical compound. During oxidation, the oxidizing agent removes one or more electrons from its reaction partner. This means that when bleach reacts with a "stain molecule" the oxidation reaction changes the chemical structure of the chromophore. The resulting molecule either does not contain a chromophore anymore or the chromophore is no longer able to absorb light in the visible range. In both cases the reaction product will not show a color, and the stain magically disappears.

The decolorizing action of bleaches is due in part to their ability to remove electrons which are activated by visible light to produce the various colors. The hypochlorite ion (OCl-), found in many commercial bleaches, is reduced to chloride ions and hydroxide ions forming a basic solution as it accepts electrons from the colored material as shown below.

*Chemical Equation*: OCl- + 2e- + HOH 🡪 Cl- + 2OH-

**Pre-Lab Questions: Answer in COMPLETE sentences!**

1. Why is grass green? Be specific!
2. What are chromophores, and what is their relevance to this lab?
3. What makes bleach an oxidizing agent?
4. How does bleach make stains disappear/make materials white?

**Materials**

* Sharpie
* 5 Dixie cups
* 50 mL bleach
* Red, blue, yellow, and green food coloring
* Plastic pipette

**Procedure**

1. Label each cup 1-5.
2. Pour 25 mL of tap water into each clear plastic cup.
3. Add food coloring to each cup. *NOTE: you will have to be patient and share with other groups!*
   * Cup 1: 2 drops blue
   * Cup 2: 2 drops red
   * Cup 3: 2 drops yellow
   * Cup 4: 2 drops green
   * Cup 5: 1 drop red + 1 drop yellow
4. Stir each solution with a glass stirring rod. Clean the stirring rod between each use.
5. Use the plastic pipette to add 3 drops of bleach to each cup. After you add bleach, swirl the cup slightly. Pay attention to color changes and how quickly the reactions happen.
6. Wait 3 minutes and make observations again.
7. Add a full pipette of bleach to each cup that still contains a colorful solution. Make observations immediately and again after 3 minutes.
8. Keep adding a small amount of bleach until each solution is colorless (light yellow). DON’T ADD TOO MUCH! Make sure to wait 3 minutes between each addition of bleach.
9. Finish making detailed observations.
10. Clean up! Solutions can go down the drain, but let the water run for 30 seconds afterward. Return leftover bleach to the “extra bleach” beaker on the counter.

**Post-Lab Questions (complete sentences!)**

1. Which solutions took longer to become colorless?
2. Why do you think these solutions took longer to become colorless? Be specific.
3. How can you speed up the rate of a reaction? Name at least two things you can do.

**PHASE TWO: DESIGN YOUR OWN EXPERIMENT!**

**Purpose**: To test the effect of oxidizing agents on stains and dyes.

**Questions to Consider:**

1. Which oxidizing agent is the “strongest”?
2. Which oxidizing agents are best for each type of stain?
3. Are more highly concentrated oxidizing agents more effective?

**Materials**

* Spot plate
* Plastic pipettes
* Water

**Oxidizing Agents**

* Liquid bleach (8% sodium hypochlorite, NaClO)
* Powder bleach dissolved in distilled water (8% solution)
* Oxalaic acid solution (1%)
* Oxy Clean
* Hydrogen peroxide (3% H2O2)
* Hydrogen peroxide (15% H2O2)
* Sodium thiosulfate solution (1%)

**Samples**

* Iodine solution (2% KI)
* Grape juice
* Rusty water
* Colored fabric
* Colored flower petals
* Grass stain on white piece of fabric
* Other ideas that you have

***Write your own procedure and make your own data table!***

**REDOX PRACTICE PROBLEMS!**

1. How do you identify the oxidizing agent and the reducing agent in a redox reaction?
2. Which of the following would most likely be oxidizing agents and which would most likely be reducing agents? Think in terms of tendencies to lose or gain electrons.
   1. Cl2
   2. K
   3. Ag+1
3. Determine the oxidation number of the element underlined.
   1. PbSO4 \_\_\_\_\_\_\_\_\_\_
   2. ClO3- \_\_\_\_\_\_\_\_\_\_
   3. HP032- \_\_\_\_\_\_\_\_\_\_
   4. Na2O2 \_\_\_\_\_\_\_\_\_\_
   5. CaH2 \_\_\_\_\_\_\_\_\_\_
   6. Al2(SO4)3 \_\_\_\_\_\_\_\_\_\_
   7. NaIO3 \_\_\_\_\_\_\_\_\_\_
   8. C4H12 \_\_\_\_\_\_\_\_\_\_
4. Al3+ + Zn → Al + Zn2+

Substance oxidized \_\_\_\_\_\_\_\_ Oxidizing agent \_\_\_\_\_\_\_\_

1. Cr2O72- + ClO2- → Cr3+ + ClO4-

Substance oxidized \_\_\_\_\_\_\_\_ Oxidizing agent \_\_\_\_\_\_\_\_

1. State the Oxidation Number of each of the elements that is underlined.
   1. NH3 \_\_\_\_\_\_\_\_\_\_
   2. H2SO4 \_\_\_\_\_\_\_\_\_\_
   3. ZnCO3 \_\_\_\_\_\_\_\_\_\_
   4. Al(OH)3 \_\_\_\_\_\_\_\_\_\_
   5. Na \_\_\_\_\_\_\_\_\_\_
   6. Cl2 \_\_\_\_\_\_\_\_\_\_